AD NUMBER
AD342945
CLASSIFICATION CHANGES
TO: unclassified
FROM: confidential
LIMITATION CHANGES
TO: Approved for public release, distribution unlimited
FROM: Notice: All requests require approval of Naval Research Lab., Wash. 25, D. C. Not re leasable to foreign nationals.
AUTHORITY
NRL ltr, 22 Apr 2002; NRL ltr, 22 Apr 2002

342945L

342945

(5) 627 400

0

(18) NRL Report 4850

Copy No 2

CONFIDENTIAL

(6) PROJECT VANGUARD REPORT NO. 9
PROGRESS THROUGH SEPTEMBER 15, 1956 (U)

[UNCLASSIFIED TITLE]

Project Vanguard Staff

(11) October 4, 1956

Further distribution of this report, or of an abstract or reproduction, may be made only with the approval of the Director, U.S. Naval Research Laboratory, Washington 25, D. C.

NOT RELEASABLE TO FOREIGN NATIONALS

NAVAL RESEARCH LABORATORY
Washington, D.C.

CONFIDENTIAL

CONFIDENTIAL

SECURITY

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Sections 793 and 794. The transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

PREVIOUS PROJECT VANGUARD REPORTS

Project Vanguard Report No. 1, "Plans, Procedures, and Progress" by the Project Vanguard Staff, NRL Report 4700 (Secret), January 13, 1956

Project Vanguard Report No. 2, "Report of Progress" by the Project Vanguard Staff, NRL Report 4717 (Confidential), March 7, 1956

Project Vanguard Report No. 3, "Progress through March 15, 1956" by the Project Vanguard Staff, NRL Report 4728 (Confidential), March 29, 1956

Project Vanguard Report No. 4, "Progress through April 15, 1956" by the Project Vanguard Staff, NRL Report 4748 (Confidential), May 3, 1956

Project Vanguard Report No. 5, "Progress through May 15 1956" by the Project Vanguard Staff, NRL Report 4767 (Confidential), June 2, 1956

Project Vanguard Report No. 6, "Progress through June 15, 1956" by the Project Vanguard Staff, NRL Report 4800 (Confidential), June 28, 1956

Project Vanguard Report No. 7, "Progress through July 15, 1956" by the Project Vanguard Staff, NRL Report 4815 (Confidential), July 27, 1956

Project Vanguard Report No. 8, "Progress through August 15, 1956" by the Project Vanguard Staff, NRL Report 4832 (Confidential), September 5, 1956

CONFIDENTIAL

CONTENTS

PROBLEM STATUS

This is an interim report; work on the problem is continuing.

AUTHORIZATION

NRL Problem A02-90

Manuscript submitted September 27, 1956

PROJECT VANGUARD REPORT NO. 9
Progress Through September 15, 1956
[UNCLASSIFIED TITLE]

PREFACE

This report is intended as a general summary of the progress on Project Vanguard during the indicated period. Hence, minor phases of the work are not discussed to a great extent, and technical detail is kept at a minimum. It is hoped that the information here presented will be of assistance to administrative and liaison personnel in coordinating and planning their activities, and as a guide to the current status of the project. Material of a more technical nature will be published from time to time in separate reports which will be announced in subsequent monthly progress reports.

COORDINATION WITH OTHER SERVICES

ARMY

By letter of 30 August 1956 the Chief Signal Officer has advised the Chief of Naval Research of the current Army capability to undertake a passive acquisition program for Project Vanguard.† At this time the program would involve the use of the Signal Corps Engineering Laboratory (SCEL) moon-tracking radar, Diana, in an effort to acquire the satellite.

By letter of 11 September 1956 the Assistant Secretary of the Navy (Air) has requested ASD (Compt) to provide the Army construction funds in the amount of $750,000 for the Minitrack station program.

AIR FORCE

Although the joint occupancy date for the launching complex, reported as 5 September in the last report,‡ is correct, Vanguard engineers will not be able to start wiring for the installation of technical equipment. It appears that the uncompleted contract work is of the type which conflicts with the accessibility to the area and the installation of technical equipment. A Work Schedule Coordinating Group, with representation form the Air Force, the Army Engineers, the construction contractor, the Glenn L. Martin Company, and the Naval Research Laboratory, has been set up in an effort to obtain maximum effectiveness during this joint occupancy period.

†P.V.R. No. 6, p. 1

‡P.V.R. No. 8, p. 1

The basic construction work on the launching complex blockhouse has been completed. Work is proceeding on installing air conditioning, power, water, etc. The gantry crane assembly has been completed with the exception of the final coat of paint; labor difficulties are delaying this phase. However, the crane can be used as is without any difficulty.

The center of the launching pad is completed. The paved area surrounding this center is not scheduled to be completed until shortly before the completion of the whole complex. Although the cable trench leading from the equipment house near the center of the launching pad to the blockhouse is on schedule, the installation of the heavy electrical cables is being delayed pending delivery of the cable brackets. These brackets are now scheduled for delivery and installation by 26 September.

The criteria for design and construction of the Minitrack facilities on Grand Turk, Mayaguana, and Antigua have been reviewed with the architectural engineering contractor. The design is scheduled for completion during the later part of September.

THE LAUNCHING VEHICLE

The latest target dates for the launching of the test vehicles and the satellite vehicles are as follows:

TV-0	20 November 1956	SLV-1	31 October 1957
TV-1	29 January 1957	SLV-2	6 December 1957
TV-2	8 March 1957	SLV-3	31 January 1958
TV-3	24 May 1957	SLV-4	28 March 1958
TV-4	26 July 1957	SLV-5	23 May 1958
TV-5	20 September 1957	SLV-6	1 August 1958

CONFIGURATION AND DESIGN

The redesign of the second-stage sleeve structure and the third-stage spin mechanism (in order to increase the third-stage clearance during separation) has been completed,† and redesign of the first-stage separation section to use explosive bolts instead of Primacord has been initiated (see page 8). These redesigns will cause a sizeable increase in the second-stage weight (20 to 30 pounds) which is not yet shown in the tabulated weight statement.

The current empty weight status of the launching vehicle is as follows:

Stage	Specification Weight (lb)	Target Weight (lb)	Current Weight (lb)
First	1782	1565	1436
Second	973	865	878
Third	89	89	82

†P.V.R. No. 8, p. 2

Supersonic wind-tunnel tests of the latest vehicle configuration are scheduled to begin 17 September at NAMTC, Point Mugu, California. Earlier scheduled tests were postponed because of the recent design changes in the Vanguard configuration. It was necessary to modify the configuration of the supersonic models since the modified nose of the vehicle is now a cone-cylinder (Fig. 1). It should be noted that the over-all nose cone length has been extended approximately 15 inches. This modification will be effective with TV-4, and redesign of the clam-shell nose cone for this and subsequent vehicles is in process. The total vehicle length remains essentially unchanged since a compensating reduction in the length of the first-stage fuel tankage has obtained from the change to kerosene as the first-stage fuel.[†] The configuration of TV-2 remains unchanged since this vehicle carries a dummy third stage. TV-1 and TV-3 will have a short transition section between the unchanged instrumented nose cone and a revised second-stage forward structure.

Arrangements are being made for transonic wind-tunnel tests of the latest vehicle configuration to be conducted at Wright-Patterson AFB to cover the speed range from Mach 0.8 to Mach 1.6, with a larger model scale. The transonic tests will consist of pressure and force runs at Mach-number increments of 0.05, varying the angle of attack ±5 degrees. It was decided to incorporate roll-jet shields on the force models in order to determine the magnitude of their effect. These tests will be run with and without the jet shields and will cover the speed range from Mach 1.6 to Mach 3.5 using force and pressure models (1.75 percent scale) and varying the angle of attack ±5 degrees.

Investigation of the matter of von Karman vortex-shedding oscillations[‡] shows that critical bending moments would be produced in the vehicle on the launch stand by wind velocities from 10 to 18 ft/sec and that the load buildup time would vary from 8 to 30 seconds. The most critical condition occurs when the vehicle is empty at a wind velocity of 18 ft/sec, for which the buildup time is 8 seconds.

Preliminary schematic diagrams and the basic electrical design for TV-3 are complete and drawings are being prepared for release.

The testing and evaluation of the first of two transistorized static inverters[††] is in progress. The Electro-Solids Corporation has indicated that the second unit will be an improved design. These static inverters are being tested and evaluated as a backup program for the rotary inverters which are the principal source of ac supply in the test vehicles. The use of a qualified static inverter would result in a saving of approximately 15 pounds in the second-stage weight.

Instrumentation lists have been prepared for all test vehicles, and a preliminary list of instrumentation for satellite launching vehicles is in process. A static B+ power supply for the accelerometers in TV's 3 and 4 has been ordered for evaluation.

PROPULSION

The horizontal propulsion functional testing of TV-0 has been successfully accomplished. The only major difficulty encountered was a leaking gasket seal; replacement of the gasket eliminated the leaking.

---

†P.V.R. No. 5, p. 3
‡P.V.R. No. 5, p. 3
††P.V.R. No. 8, p. 3

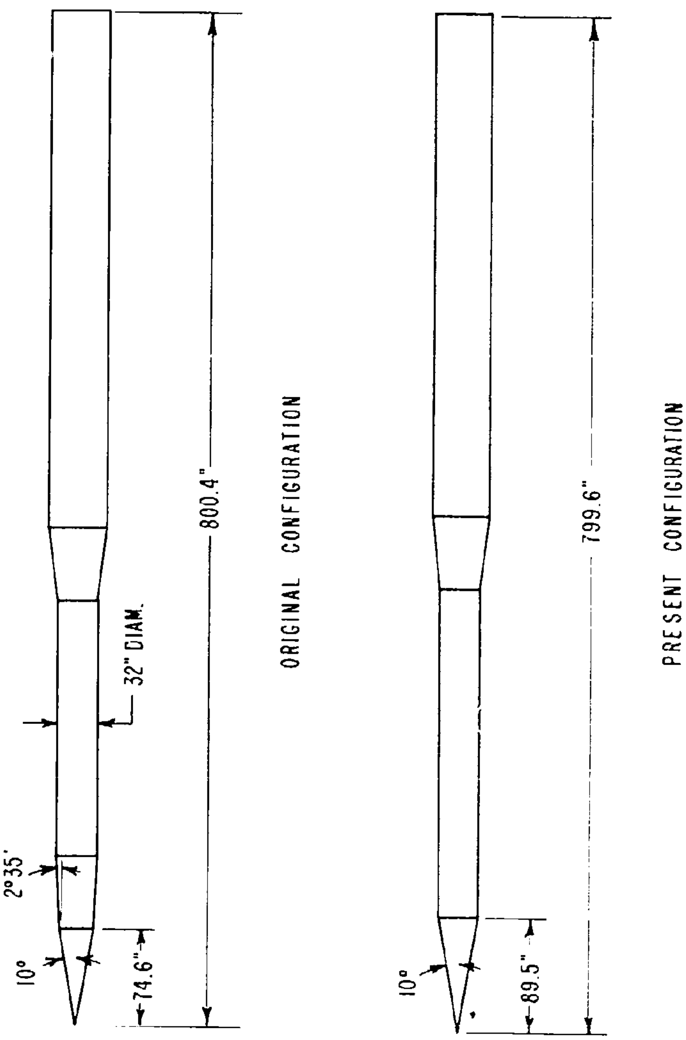

Fig. 1 - Changes in the Vanguard vehicle configuration

Preliminary propulsion system component test procedures have been prepared to aid in determining allowable leakage rates and current drains for all of the major vendor-supplied components. The allowable limits for each of the components, which will be determined by the testing of the first few delivered, will be used as a basis for acceptance or rejection of all later items.

First Stage

Since the last report the General Electric Company has had considerable difficulty with injectors for the first-stage engine; several of the injectors, when tested in the firing pit, burned out after 10 or 20 seconds of firing. The drilling pattern of the injectors was the same as that of a previous successful "workhorse" injector and initially no cause could be found for these burnouts. The problem was resolved when it was discovered that the injectors which were failing had "square" entrance manifolds with a poor flow distribution. New shop instructions were issued for the manufacture of rounded entrance manifold injectors with the same degree of "rounding" as the workhorse injector. The workhorse injector, in the meantime, was fire-tested and several full-duration runs were made during this report period, most of them successful. In one case, failure of a turbopump seal was responsible for premature shutdown; in another case, shutdown occurred because an electrical plug loosened and shut off the peroxide flow control valve. However, no failures were attributed to errors in fundamental design and no burnouts occured in the chamber or in the injector due to excessive heat rejection or to chamber temperature. Then, the new injectors based on the plans of the successful injector were put into service. A full-duration (150-second) run was successful, with no signs of incipient burnout.

The acceptance and qualification procedures to be employed at GE's Malta Test Station were reviewed. The first-stage engine has, during this report period, moved closer to the final qualification test. The company is now on schedule. The turbopump is working satisfactorily, the thrust chamber and injectors are not being scored, the injectors are reproducible and the valves and other components, with a few minor exceptions, are working properly. Therefore no difficulty is anticipated in delivering the first-stage rocket engine assembly to the Glenn L. Martin Company on schedule.

Second Stage

A wire-wrapped "spaghetti" type (aluminum-tube) second-stage thrust chamber has been successfully fired for up to 150 seconds. Aerojet had not been able to obtain a full-duration† firing during the last report period, and several cracks in the tube welding, wire failures, and injector head-closure failures had raised doubts that delivery could be made on schedule. With the present "breakthrough" on the chamber operation, one large element of the second-stage powerplant complex has been resolved.

This success has been achieved, however, with an injector which does not yield the characteristic exhaust velocity (C^*) which at 200 psia chamber pressure would give the rated specific impulse of 278 seconds at altitude.‡ It was not certain at the time of the last report that this specific impulse could be obtained in the time available; however, with the present value of C^* (4850 to 4900 ft/sec) and about 210 psia chamber pressure it should be possible to obtain a specific impulse of about 275 seconds at altitude.

---

†The maximum rated burning time is 120 seconds; the nominal value, 116.5 seconds.

‡P.V.R. No. 5, p. 8

Aerojet is striving for a C^* of about 5000 ft/sec and has obtained this with another injector. However, at this combustion efficiency or characteristic exhaust velocity the heat rejection rate is so great that it is feared the coolant will be driven beyond its saturation temperature and will film-boil and burn out the tubes. Fortunately the case is not hopeless, since a slightly increased jacket pressure or increased coolant velocity will bring the acid back into a cooling domain. The present tests show that the current second-stage engine will have a performance which, although marginal when specific impulse is considered, will be reliable and free from combustion instability or incipient burnouts.

During the last report period Aerojet had hoped to obtain lightweight tankage material which would save several pounds in the structure of the second stage. Fabrication and procurement difficulties arose, however, and this scheme has been abandoned and the 410 stainless steel tankage system is being pursued. Many welding and fabrication difficulties have shown up but increased quality control by engineering and manufacturing should, in the near future, assure a tank which will stand up under the working pressures and man-handling required in the field. There is nothing fundamentally wrong with the tank design; the difficulties are only those of production. The test facilities have been increased in scope and magnitude, and tests of heavy-walled tanks are being conducted at the Azusa test station. The Sacramento test station is being prepared for prequalification tests of the thrust chamber and gas pressurization system. The heated-helium pressurizing system has shown some difficulties with uneven pressurizing regimes, but the helium pressure regulator should smooth out these pulses.

Third Stage

The Grand Central Rocket Company (GCR) and the Allegany Ballistics Laboratory (ABL) have both made satisfactory progress during this report period. GCR has had difficulties with metal case deliveries, with instrumentation,and with the determination of performance parameters. Agreement was reached that instrumentation at GCR would be improved and that the thrust of their third-stage rocket would be measured. GCR had previously stated that a thrust measurement would prejudice its delivery schedule; however, it was decided that GCR should measure this thrust with a simplified mounting fixture for the propellant case.

GCR also has resolved the problem of propellant separation from the case, which had troubled them in previous firings, by inserting a polysulphide liner between the solid propellant and the metal case, thus producing a satisfactory bond. The company has fired its 5th light-walled motor, which has approximately the weight required for the final Vanguard configuration. No evidence of overheating was recorded. The combustion efficiency of these motors was within approximately 5 percent of that required by specification. Improved blending and casting processes and the use of a slightly higher chamber pressure should bring the measured specific impulse close to that required. The problem of long ignition delay has not yet been resolved but it is believed that a new approach to bonding and loading the igniters will guarantee reliable starts. If then, altitude ignition cannot be demonstrated, a foolproof throat closure for the motor will be developed and used.

A GCR lightweight steel case is shown in Fig. 2.

ABL has fired its first full-scale light-walled plastic motor. Previously the company had only fired heavy-walled steel cases and had had several structural failures at the nozzle end of the chamber due to the shearing of supporting bolts and various plastic members. ABL has had some difficulty in obtaining the proper graphite for the throats. (This graphite, made by the National Carbon Company, is of a peculiar blend and consistency and is eminently suitable for rocket throats.) However, some of this graphite has been released by the AEC, and thus ABL will be able to continue firing tests. The combustion efficiency of the ABL double-based propellant has been within 3 percent of the expected performance, and with the construction of the final case and close quality control of the casting process the expected performance will be obtained.

Both GCR and ABL are on schedule in their firings and in the testing of cases; nozzles and other components will be ready for prequalification tests by mid-September. The last area of difficulty is the development of a reliable igniter for both contractors, and the possible necessity of suppressing some combustion oscillations in the chamber pressure of the GCR motors. Both contractors should have a developed article by 15 October.

Fig. 2 - Grand Central Rocket Company lightweight steel third-stage case after a 30-second firing

FLIGHT CONTROL

Guidance

Reference System

The requirement for prelaunch cooling of the reference system has been established as 40 cfm of air at 40°F. Designing of the air lines, disconnects, and ground air supply is underway. Development work on the shockmounting of the gyro assembly is nearing completion and no difficulties are expected in this area. Information has been forwared to the Minneapolis-Honeywell Company concerning the four pitch-program rates required for TV-3, which is the first vehicle to fly the Vanguard reference system. The model specification for the three-axis gyro reference system has been received and is being reviewed.

Attitude Control

The first tests performed on the breadboard model of the Vickers, Incorporated, autopilot magnetic amplifier have shown that the unit has inadequate frequency response characteristics. Subsequently, Vickers has made several design changes which have been incorporated in the breadboard model, and further tests indicate a marked improvement in performance. Tests of the breadboard magnetic amplifier are being made with the first-stage dynamic controls mockup. The Model specification for the magnetic amplifier has been received from Vickers and is being reviewed. The first production-type autopilot is scheduled for completion by mid-September and will be used for qualification tests.

REAC runs have been completed on the first-stage roll jet system and the second-stage pitch-yaw jet system. The results agreed in general with previous phase plane analyses. The maximum errors obtained were 4 degrees in roll and 2 degrees in pitch-yaw.

Studies have been made to determine the maximum first-stage engine deflection required to maintain vehicle stability in the presence of the expected wind profiles and gusts. This effort is directed toward selection of a deflection limit which will provide a correcting moment in excess of the probable wind disturbance but less than that determined by vehicle structural limitations. Electrical and mechanical methods have been examined which restrict engine motion to a circular deflection as measured from the vehicle longitudinal axis. Analysis of this problem is continuing.

Hydraulic Systems

Preliminary arrangements have been made with General Electric Company to test the hydraulic servos with the first-stage engine during a test firing. The second-stage hydraulic servos have been modified to facilitate installation of propulsion system components.

Flight Program and Staging

Computer studies of the clearance between the third and second stages during separation have led to a redesign of the second-stage forward structure in order to provide a greater margin of safety against the danger of collision.

A redesign of the first- and second-stage separation structure has been initiated. Since tests of simulated Primacord installations showed a high probability of shrapnel damage to vital components in the region,† six double-primer explosive bolts will be used to effect separation. However, in view of the weight saving afforded by the Primacord method, further tests will be conducted with reduced-strength Primacord as a backup measure.

Engineering drawings have been partially completed for the lox tank dome impingement test planned by the Aerojet General Corporation to determine the impingement pressure which will be experienced by the first-stage structure if the second-stage engine is ignited during separation.‡

The Glenn L. Martin Company has been requested to provide a separation design proposal based on delayed ignition of the second stage following physical separation of the first and second stages.††

The Atlantic Research Corporation has delivered six live and six inert spin or retro motors to the Glenn L. Martin Company. These are for mounting tests and are prequalified only. Their performance has been within specification, however, and qualification tests are expected to confirm this. No delivery problem is expected.

Designers for Industry, Incorporated, has breadboarded the programmer. The delivery will be behind schedule but will be acceptable; the delay was occasioned by a necessity to change vendors at a late date.‡‡ Information on the TV-3 time sequences has been established and given to the subcontractor. The programmer has 10 channels which are used to time the pitch program, lock out the second-stage separation circuits, initiate nose-cone jettison, and back up third-stage separation. Provision for telemeter time impulses may be made.

†P.V.R. No. 8, p. 8
‡P.V.R. No. 7, p. 9
††P.V.R. No. 4, p. 10
‡‡P.V.R. No. 8, p. 8

A breadboard model of the integrating accelerometer coasting-flight time computer has been completed and tests have begun; the design of the prototype unit is nearly complete. The qualification test specification and the acceptance test specification for this device have been received from Air Associates, Incorporated, and are being reviewed.

GROUND EQUIPMENT

Ground wiring diagrams for the Vanguard launching complex have been released and the necessary equipment and hardware are being delivered or are on order for early delivery. The installation of this system is on a tight time schedule, but it is not anticipated that it will cause delay in the firing schedule.

A brief analysis of the requirement for cooling air for the Vanguard controls equipment has been started. The design of the necessary ground equipment to supply this air has also begun on the basis of preliminary data from the analysis.

The preliminary design of a liquid-oxygen heat exchanger has been completed. This heat exchanger will be used to temperature-condition the first- and second-stage helium and the cooling air for the controls equipment.

The requirements for the second-stage fuel and oxidizer temperature-conditioning trailers have been established and vendors contacted. Two proposals have been received and are being evaluated.

THE SATELLITE

CONFIGURATION AND DESIGN

A drawing of the 20-inch satellite is shown in Fig. 3, and the disassembled model is shown in Fig. 4. It will be seen that the antenna mounts, 90 degrees apart, are fastened by tubular rods to a tubular ring which is concentric with the cylindrical internal package. This ring is also supported by four bow-shaped vertical tubular members, spaced 90 degrees apart at angles of 45 degrees to the antenna supports, fastened to the support ring of the access port (see section B-B) at the "top," and to the main support column (which houses the separation mechanism) at the "bottom." The cylindrical internal package (Fig. 5) is mounted on the main support column and is also secured to the concentric tubular ring by four low-thermal-conductivity radial supports spaced 90 degrees apart at angular positions between the antenna supports and the vertical members. The sphere is girdled by two pressurized zones or bands, one below the equator and one above. Several contemplated skin-mounted instruments are shown. Not shown are four microphone pickups, two of which will be located on the upper shell midway between the pressurized zone and the support ring of the access port, the other two on the lower shell midway between the pressurized zone and the heavier skin area around the base. The upper two will be angularly positioned 90 degrees from the lower two, so that there will be a pickup every 90 degrees about the vertical axis.

A full-scale aluminum model of this satellite incorporating all of the latest design features, has been completed for use in structural and thermal tests and in familiarizing the various instrumenting groups with the design. The production units from the contractor will be identical to this model except for materials.

A drawing of the nominal 6-inch (actual inside diameter 6.40 inches, outside 6.44 inches) satellite is shown in Fig. 6, and the disassembled model is shown in Fig. 7. It will be seen that in this case the low-thermal-conductivity radial supports for the internal package are fastened directly to the antenna mounts, through holes in the two concentric gold-plated heat shields. The internal package is supported at the "bottom" by three more low-thermal-conductivity rods, and is braced or snubbed at the "top" by a similar rod connected to the access port.

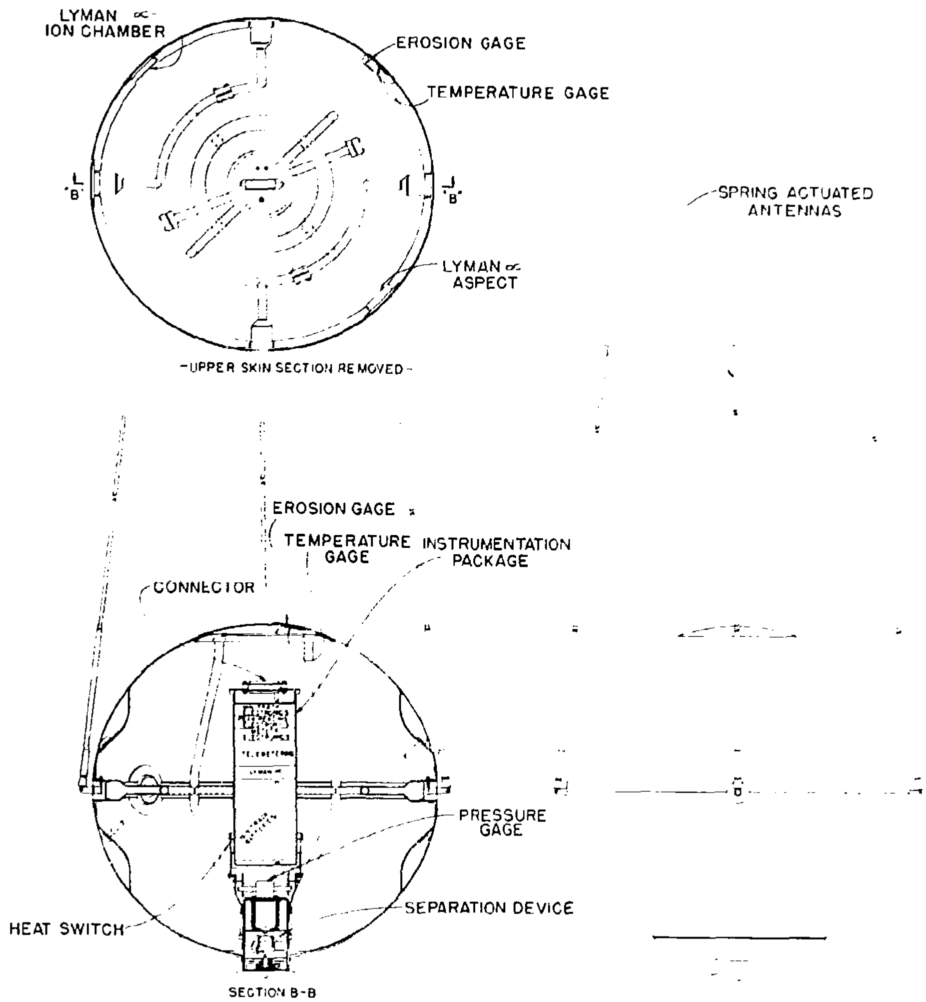

Fig. 3 - Drawing of 20-inch satellite

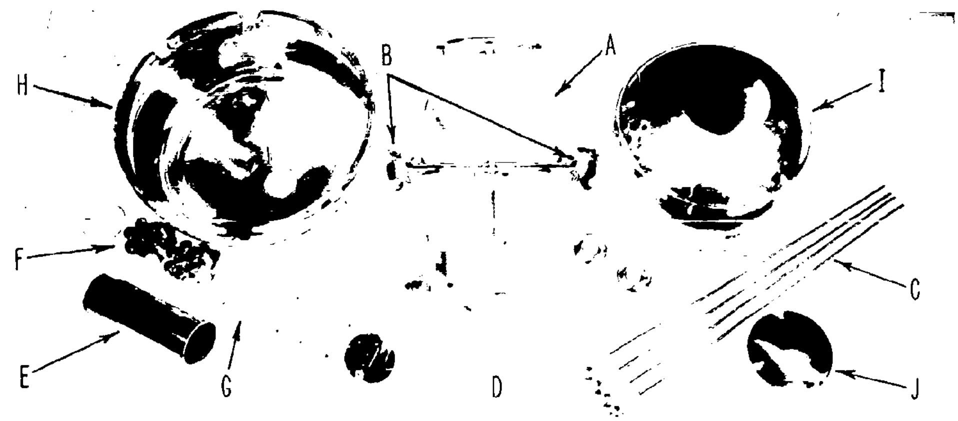

Fig. 4 - Disassembled 20-inch satellite model: A, tubular internal structure; B, antenna mounts; C, spring-actuated antennas; D, low-thermal-conductivity supports for internal package; E, internal package cylinder; F, batteries; G, instrumentation "modules"; H, lower hemisphere showing hole for main support column; I, upper hemisphere showing access port; J, access port cover

Fig. 5 - Internal package for the 20-inch satellite

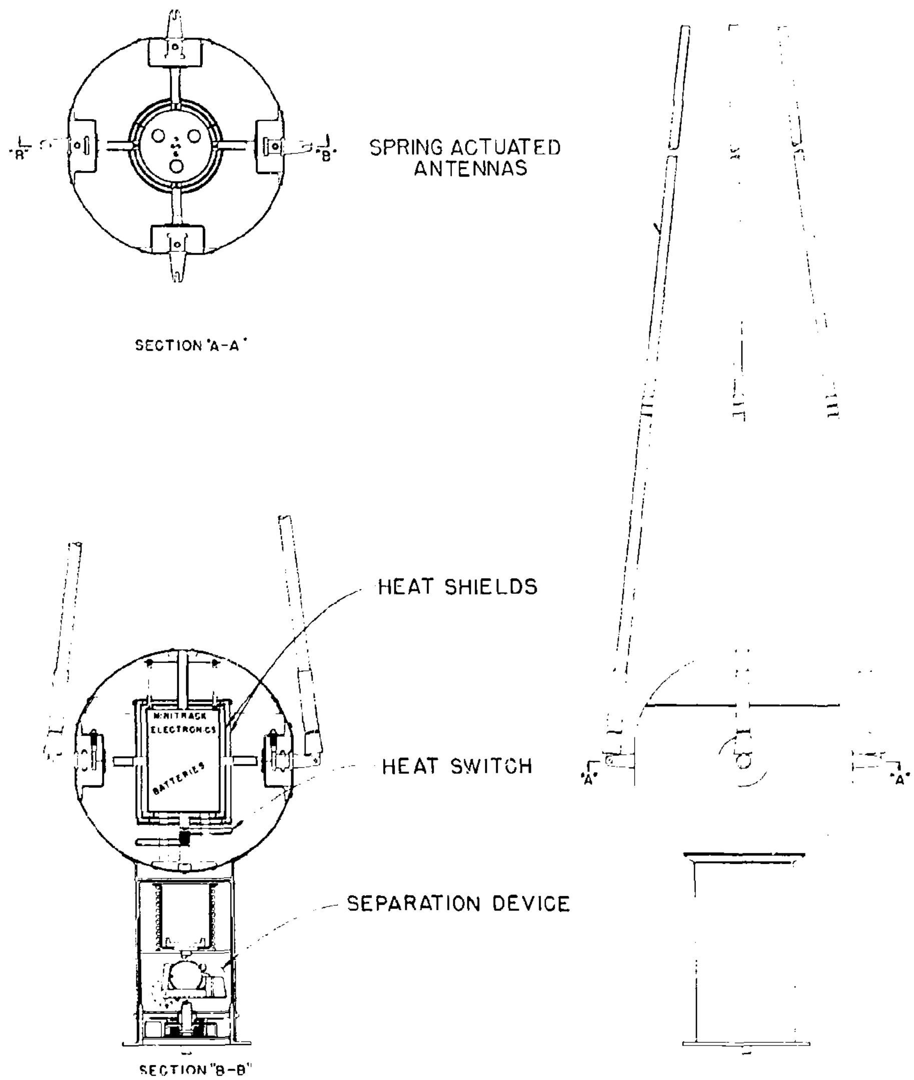

Fig. 6 - Drawing of nominal 6-inch (minimum) satellite

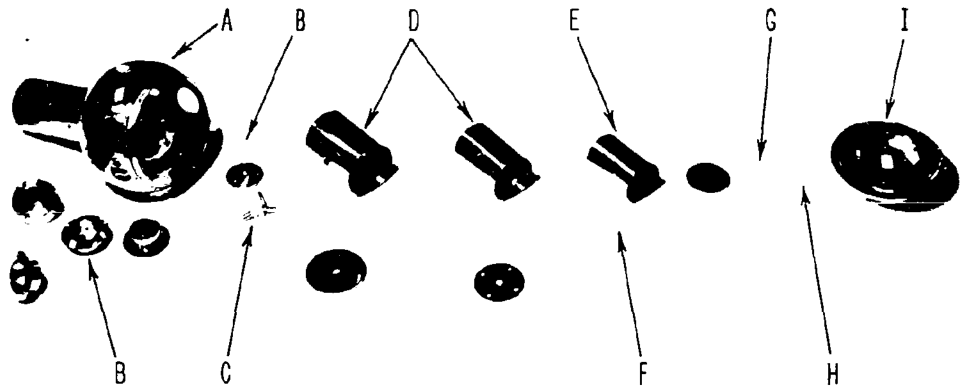

Fig. 7 - Disassembled minimum satellite model: A, outer shell and support column; B, low-thermal-conductivity bottom supports for internal package; C, heat switch; D, heat shields; E, internal package cylinder; F, low-thermal-conductivity radial supports for internal package; G, wiring support; H, low-thermal-conductivity "snub" for top of internal package; I, access port cover

The delivery of the first four production units from Brooks and Perkins, Incorporated, is scheduled for 28 September 1956. In order to facilitate rapid assembly upon receipt of these satellites, NRL is currently fabricating the "Kel-F" parts and the heat switches.

An aluminum model of the present design has proved adequate from the thermal isolation standpoint; however, temperature cycling tests are continuing for the purpose of determining the effects of changing the thermal isolation parameters.

The heat switch for the minimum satellite (Fig. 8) has been tested and operated satisfactorily; the tests are being continued. The design of the heat switch for the 20-inch satellite is complete and the manufacture of one four-switch assembly is nearing completion. Tests of these units are scheduled to begin about 1 October.

The experiments on potting compounds for mounting the spring-actuated antennas have been discontinued and the antenna design has been changed to permit the use of a split Teflon insert (Fig. 9). Preliminary tests indicated that the new design is more than adequate structurally. The 72 antenna assemblies have been completed ahead of schedule.

The construction of some of the parts for the separation mechanism was scheduled to begin on 12 September. However, the drawings have not been completed; the estimated date for completion of the drawings is 21 September, after which construction of the parts will proceed.

A balancing arbor has been manufactured for dynamically balancing both the 6-inch and 20-inch satellite about their spin axes. Preliminary balancing of the 20-inch model will be undertaken shortly to familiarize personnel with the problems involved in dynamic balancing.

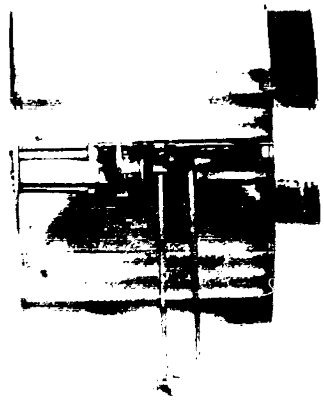

Fig. 8 - Heat switch assembly for minimum satellite

Fig. 9 - New satellite antenna mounting system

INSTRUMENTATION

Drawings have been completed which show the dimension details of the instrumentation modules for the internal package. Layouts of a printed circuit prototype satellite telemetry coding system are underway as well as a study of the requirements of the various scientific experimenters so that the information channels may be allocated equitably. The final channel allocations will be made in the near future.

An order has been placed for ground station tape recording equipment. Delivery of the first unit for testing and for training of the operators will be made in early December 1956, and all units for field use are to be delivered by February 1957. Equipment for transcribing tape-recorded data onto 35-mm photographic film is being constructed for use at NRL.

Work has begun on a linear detection circuit for the ground telemetering receivers.

Several experimental models of evaporated-Nichrome satellite erosion gauges have been bombarded with low-velocity particles (3 microns in diameter) from an air gun. Reproducible curves of resistance versus erosion time were obtained. Tests are scheduled for the month of September to determine the effects of temperature and pressure environments on the stability of the erosion gauge.

THEORY AND ANALYSIS

A method of determining impact probability distribution contours for the launching vehicle has been developed and furnished to the Glenn L. Martin Company for use in calculating range safety information. Impact probability distribution contours for TV-0 have been calculated and furnished to AFMTC.

A program has been developed for determining the effects of upper air winds on the operation of the launching vehicle. This program was furnished to the Glenn L. Martin Company in order that a detailed study can be made.

ELECTRONIC INSTRUMENTATION

A field laboratory has been established in Hangar C at Cape Canaveral to provide test facilities for telemetering and range instrumentation equipment. Both telemetering trailers have been shipped to AFMTC and the installation of ppm/am and pwm/fm telemetering ground stations is underway.

Horizontal and vertical interference tests have been conducted at the Glenn L. Martin plant on all electronic instrumentation for TV-0; the results were acceptable.

The Naval Research Laboratory received 120 rolls of 9-inch Verichrome film (for ground-station recording) from Eastman Kodak Limited of London, England; this has been tested and shipped to PAFB.

TELEMETERING

PPM/AM Systems

The prototype AN/DKT-7 ppm/am vehicle telemetering transmitter was received on 4 September. The results of subsequent electrical tests show satisfactory operation, and mechanical tests are being scheduled. The James Spivey Company has indicated that they will make every effort to deliver the first production unit on 24 October; the contract does not require delivery until November. The company has been asked to deliver five additional rf transmitting heads for these transmitters on 1 November.

Two AN/DKT-7 transmitters and two calibrators have been delivered to the Glenn L. Martin Company for use as TV-1 flight and spare equipment.

The third Elsin Electronics Company ppm/am ground station, two additional monitor racks, and three film magazines have been received and shipped to PAFB. Delivery of the fourth Elsin ground station is scheduled for 29 September. One complete ppm/am ground station has been shipped from PAFB to Grand Bahama Island.

Requests for proposals to supply NRL with twelve ppm/am video recorder film magazines have been sent to selected contractors.

PWM/FM Systems

All pwm/fm vehicle telemetering transmitter components have been delivered to the Glenn L. Martin Company for TV-1, and other components are being tested and calibrated for subsequent vehicles. A new transmitter package is being designed for use in TV-3. Recordings of NRL vibration tests of the pwm/fm transmitter have been studied by the manufacturer (ASCOP) and recommendations for improving these units are under consideration.

The preamplifiers and multicouplers of the pwm/fm ground station are being modified: the center frequency is being changed so that the bandwidth will accommodate the new frequency assignments.†

Three NEMS-Clarke 400 receivers for pwm/fm ground station use have been obtained from a BRL contract with that company, and are scheduled for delivery during September.

FM/FM Systems

The Hoover Electronics Corporation has been supplied the strain gauge oscillator which was the last subcarrier oscillator required for the TV-1 prototype fm/fm telemetering transmitter. This transmitter is scheduled for delivery to NRL during the week of 17 September for acceptance tests.

Calibration and field maintenance procedures are being set up for the AN/UKR-5 fm/fm and pwm/fm ground station, and a study is being made to find means of extending the number of pwm channels the unit can accommodate.

VEHICLE TRACKING

Modifications to the T-11 DOVAP transponder have enabled it to withstand the Vanguard vibration tests,‡ and in addition better output stability at high temperature has been achieved.

Two modified AN/DPN-19 radar beacons and one T-11 DOVAP transponder have been shipped to the Glenn L. Martin Company for TV-1. One AN/DPN-31 C-band radar beacon scheduled for use in TV-1 has been completed and tested and was shipped to NRL on 14 September. This beacon will be delivered to the Martin Company on or about 26 September.

The S-band and C-band radar beacons being manufactured by Melpar (Melpar 1245), which have been referred to in these reports†† as the AN/DPN ( ), have been assigned the

†P.V.R. No. 8, p. 12
‡P.V.R. No. 8, p. 13
††P.V.R. No. 4, p. 13; No. 5, p. 15; No. 6, p. 12; and No. 7, p. 12

nomenclature AN/DPN-48(XE-1). The first S-band unit is scheduled for delivery on 20 September. The third-stage wiring for TV-1 has been planned so that either the modified AN/DPN-19 beacon or the AN/DPN-48(XE-1) may be used. However, it is planned to replace the DPN-19 with the DPN-48(XE-1) as the latter becomes available. Delivery of the first DPN-48(XE-1) C-band unit is expected about 4 October.

Nine AN/ARW-59 range safety command receivers and KY-55/ARW decoders have been received and are undergoing modification. Bids for the manufacture of AN/ARW-59 receivers for the satellite launching vehicles are being reviewed.

THE MINITRACK SYSTEM

GROUND STATION UNITS

Contract Nonr 2190(00) with the Bendix Radio Division of the Bendix Aviation Corporation for eleven Minitrack ground station units is proceeding on schedule. Releases have been given for the procurement of all electronic components and for the production of all racks; complete production release of all items is required by 1 October 1956. All government-furnished equipment has been ordered, and several prototype chassis have been provided Bendix for study and for engineering production estimates.

Under this contract the first two complete ground station units are to be supplied NRL by 6 April 1957 for trailer installation and shipment to the Mayaguana and Grand Turk sites, there to be in operation by 24 May 1957. Negotiations are underway to have Bendix install these two units in trailers at Towson, Maryland, after NRL has prepared the trailers. In this way, the final system checks could be made at the Bendix plant and the two units shipped directly to their overseas sites from there. The remaining nine units, installed in the trailers, are to be supplied to NRL at the rate of one per week beginning 1 May 1957.

STATION SITE PREPARATION

Complete station site criteria have been furnished the Army Corps of Engineers for use in preparing the seven Minitrack stations for which they are assuming responsibility. The final design of the antenna support posts will be furnished them by 1 November. According to the present schedule, the antenna support post and rail assembly should be placed and the rf transmission line buried at each of the sites by 1 July 1957. Thus the antennas can be assembled during July 1957 in preparation for the arrival of the Minitrack ground station units during August 1957.

At a meeting between the Coral Gables Resident Officer in Charge of Construction, and Air Force representatives, the final criteria of the Mayaguana, Grand Turk, and Antigua stations were specified. The ROICC has set 30 September 1956 as a target date to have the design for these stations ready for review.

Representatives of NEL have arrived at NRL to discuss the San Diego tracking station, plans for which have been slowed up by a lack of funds for land acquisition.

MINITRACK TRANSMITTERS

Work is continuing on the high-power (100-milliwatt) satellite transmitter† for continuous telemetering; both transistor and vacuum tube oscillators are being built. Philco is still having difficulty in the production of transistors with a sufficiently high efficiency and lifetime for this application, although excellent mechanical characteristics have been achieved. Bell transistors with an efficiency of 30 percent at 100 milliwatts output have been life tested, and no signs of deterioration were apparent after 12 days. However, while this transistor appears to be electrically suitable, there is doubt as to its mechanical stability under shock and vibration. This problem will be further investigated.

CALIBRATION

A Mark 51 gun director, equipped with binoculars, has been installed as an interin Minitrack calibration device at Blossom Point. Elevation and azimuth data from this director can be recorded on the Sanborn recorder which records the electrical data from the Minitrack system. Two calibration runs have been made with Minitrack transmitters carried in an AD-4 airplane; the data reduction is not yet complete.

The astrographic camera, with an equatorial mount drive, has been completed and will be evaluated at NRL. This camera is intended for use in the final calibration system to photograph the transmitter-carrying aircraft against a star background.

DATA PROCESSING

TELEMETERED DATA

Although the contract for the automatic recording and reduction facility for telemetered data has not yet been signed, Radiation, Incorporated, has been proceeding on detailed planning and design of the equipment.

ORBITAL DATA

The International Business Machines Corporation has now assigned three mathematicians full time to the work of programming the 704 computer for orbit computations. The program for the product of two Fourier series‡ has been prepared but has not yet been checked on the computer. The mathematical formulation for calculating an elliptic orbit with a minimum number of observations has been presented to the IBM mathematicians for programming.

SECOND-STAGE APOGEE PREDICTION

For predicting the time to fire the third stage, it is planned to use the radar tracking data for a period of thirty seconds beginning five seconds after second-stage fuel cutoff.

---

†P.V.R. No. 8, p. 14
‡P.V.R. No. 8, p. 16

The kind of smoothing to be used on these data by the computer (the IBM 704 computer located at Cape Canaveral) has been under study by AFMTC in cooperation with NRL. By 40 seconds after fuel cutoff, the computer will have calculated the predicted firing time and all pertinent information will have been presented at the control console. By 60 seconds after fuel cutoff, it is assumed that the operator of the control console will have decided whether to give a ground command for firing the third stage or to allow the integrating accelerometer mechanism in the vehicle to accomplish the firing. If a ground command is given, it will be given between 60 and 180 seconds (say, 120 seconds) after fuel cutoff to switch the firing circuit from the integrating accelerometer to a fixed time-delay mechanism. If the third-stage firing time expected for a given launching were 250 seconds after second-stage fuel cutoff, the fixed delay used would be 130 seconds. This would allow a variation in the actual firing time by ground command of ±60 seconds about the nominal value of 250 seconds.

NRL and the Glenn L. Martin Company have agreed that NRL will design and build the control console and that the company will furnish the appropriate equipment in the vehicle to accomplish the third-stage firing by ground command.

* * *

Naval Research Laboratory. Report 4850 (CONF.) PROJECT VANGUARD REPORT NO. 9 - PROGRESS THROUGH SEPTEMBER 15, 1956 (Unclassified Title), by Project Vanguard Staff, 19 pp. and figs., October 4, 1956.

1. Satellite vehicles - Launching
2. Satellite vehicles - Research
3. Rockets - Development

I. Project Vanguard

Naval Research Laboratory. Report 4850 (CONF.) PROJECT VANGUARD REPORT NO. 9 - PROGRESS THROUGH SEPTEMBER 15, 1956 (Unclassified Title), by Project Vanguard Staff, 19 pp. and figs., October 4, 1956.

1. Satellite vehicles - Launching
2. Satellite vehicles - Research
3. Rockets - Development

I. Project Vanguard

Naval Research Laboratory. Report 4850 (CONF.) PROJECT VANGUARD REPORT NO. 9 - PROGRESS THROUGH SEPTEMBER 15, 1956 (Unclassified Title), by Project Vanguard Staff, 19 pp. and figs., October 4, 1956.

1. Satellite vehicles - Launching
2. Satellite vehicles - Research
3. Rockets - Development

I. Project Vanguard

Naval Research Laboratory. Report 4850 (CONF.) PROJECT VANGUARD REPORT NO. 9 - PROGRESS THROUGH SEPTEMBER 15, 1956 (Unclassified Title), by Project Vanguard Staff, 19 pp. and figs., October 4, 1956.

1. Satellite vehicles - Launching
2. Satellite vehicles - Research
3. Rockets - Development

I. Project Vanguard

DISTRIBUTION

	Copy No.
DEPARTMENT OF DEFENSE (41 copies)	
Asst. Secretary of Defense (R&D)	1-30
Asst. Secretary of Defense (R&D) Attn: J. C. Myers	31-40
Asst. Secretary of Defense (Compt) Attn: Prog. Rpts. & Statistics Div.	41
NAVY DEPARTMENT (29 copies)	
Asst. Secretary of Navy (Air)	42
CNO Attn: Op-51 (2) Op-05 (1)	43-45
Navy Comptroller	46
ONR	47-56
NOTS, China Lake, Calif.	57
NAMTC, Pt. Mugu, Port Hueneme, California	58
BuOrd Attn: Code ReSl (1) Code Sp (1)	59-60
BuAer Attn: GM-12	61
BuY&D Attn: Cdr. L. P. Frate (1)	62
Western Dev. Div., Air Res. & Dev. Com., 401 E. Manchester Blvd., Englewood 45, Calif. Attn: Navy Liaison Officer	63
BuShips	64-65
Navy Liaison Officer, PAFB	66
OinC, Navy Unit, PAFB	67
SenNavOfficer, Navy Office, ABMA Redstone Arsenal	68
USNEL Attn: Code 2220	69
Naval Observatory, Washington, D. C. Attn: Dr. G. M. Clemence	70
DEPARTMENT OF THE ARMY (37 copies)	
Asst. Secretary of Army (R&D)	71
Asst. Secretary of Army (Log)	72
Office of Chief of Staff (Army) Attn: DCS Log (Plane and Programs) (1) Chief R&D (9) CS Mil Ops (1)	73-83
Office of Chief of Ordnance ORDTB (1) ORDTU (1)	84-85
Office of Chief Signal Officer Attn: SIGAC (3) SIGRD (1)	86-89
Office of Chief of Engineers Attn: EID (ENGIT) (1) R&D (ENGNB) (1)	90-91
Signal Corps Engineering Lab. Dir. of Research (2) Tech. Library (1) Dir. of Engineering (2)	92-96
Army Map Service Attn: CO (1) Mr. John O'Keefe (1)	97-98
Ballistic Research Lab., Aberdeen, Md.	99
Diamond Ordnance Fuze Lab., Wash., D. C.	100
White Sands Proving Ground Attn: ORD Mission	101
Redstone Arsenal Attn: R&D (1) Tech. Lib. (1)	102-103
ABMA, Redstone Arsenal	104-106
Los Angeles Ordnance District, 55 So. Grand Ave., Pasadena, Calif. Attn: ORDEV-00	107
DEPARTMENT OF THE AIR FORCE (43 copies)	
Asst. Secretary of Air Force (R&D)	108
Deputy Chief of Staff, Dev. U.S. Air Force	109-111
Asst. Chief of Staff, USAF Guided Missiles	112
Patrick Air Force Base, Fla. Attn: AFMTC (3) Com., AFMTC (MTTP Vanguard) (15)	113-130
Directorate of Dev. Planning, USAF (AFDAP) (8)	131-138
WADC, Wright-Patterson AFB, Ohio Attn: WCOSI-3	139-143
ARDC, Baltimore, Md.	144-146
AFCRC, ARDC Bedford, Mass. Attn: CRRT	147
Western Dev. Div., Air Res. and Dev. Command, 401 E. Manchester Blvd., Englewood 45, Calif. Attn: CDR. R. C. Truax	148-149
Air Res. and Dev. Command, Griffiss AFB, Rome, N. Y. Attn: RCENW	150
OTHER (15 copies)	
NSF	151-152
Glenn L. Martin Co., Baltimore, Md. (5)	153-157
General Electric Co. (Wash. Office), Wyatt Bldg., Washington, D. C. Attn: J. H. Bernhart	158
Aerojet-General Corp., Azusa, Calif.	159
International Business Machines Corp., 1111 Conn. Ave., N. W., Washington 6, D. C. Attn: Dr. T. R. Horton (6)	160-165
NRL (Internal Distribution) (66 copies)	166-173

Naval Research Laboratory
Technical Library
Research Reports Section

DATE: April 22 2002

FROM: Mary Templeman, Code 5227

TO: **Code 8001 Mr. Fred Hellrich**

CC: Tina Smallwood, Code 1221.1 ts 4/25/02

SUBJ: Review of NRL Reports

Dear Sir/Madam:

1. Please review NRL Report 4969, 4850, 4700 and MR-487 for:

- [x] Possible Distribution Statement
- [ ] Possible Change in Classification

Thank you,

Mary Templeman

Mary Templeman
(202)767-3425
maryt@library.nrl.navy.mil

The subject report can be:

- [x] Changed to Distribution A (Unlimited)
- [ ] Changed to Classification _____ __
- [ ] Other:

Fred J Hellrich 4/24/02

Signature Date

-- 1 OF 1
-- 1 - AD NUMBER: 342945
-- 2 - FIELDS AND GROUPS: 21/8.1, 21/8.2, 22/2, 22/4
-- 3 - ENTRY CLASSIFICATION: UNCLASSIFIED
-- 5 - CORPORATE AUTHOR: NAVAL RESEARCH LAB WASHINGTON D C
-- 6 - UNCLASSIFIED TITLE: PROJECT VANGUARD REPORT NO. 9 PROGRESS
-- THROUGH SEPTEMBER 15, 1956.
-- 8 - TITLE CLASSIFICATION: UNCLASSIFIED
--11 - REPORT DATE: 4 OCT 1956
--12 - PAGINATION: 19P MEDIA COST: $ 7.00 PRICE CODE: AA
--14 - REPORT NUMBER: NRL-4850
--20 - REPORT CLASSIFICATION: [redacted]
--22 - LIMITATIONS (ALPHA): NOTICE: ALL REQUESTS REQUIRE APPROVAL OF
-- NAVAL RESEARCH LAB., WASH. 25, D. C. NOT RE LEASABLE TO FOREIGN
-- NATIONALS.
--23 - DESCRIPTORS: (*SCIENTIFIC SATELLITES, RE), LAUNCH VE,
-- CONFIGURATION, DESIGN, WEIGHT, ROCKET MOTORS (LIQUID PROPELLANT),
-- ROCKET MOTORS (SOLID PROPELLANT), BOOSTER, SECOND STAGE MOTORS,
-- THIRD STAGE, FLIGHT CONTROL SYSTEMS, HYDRAULIC, TRACKING.
--24 - DESCRIPTOR CLASSIFICATION: UNCLASSIFIED
--29 - INITIAL INVENTORY: 1
--30 - ANNOTATION: PROJECT VANGUARD REPORT NO. 9.
--32 - REGRADE CATEGORY: C

-
--33 - LIMITATION CODES: 5
--35 - SOURCE CODE: 251950
--36 - ITEM LOCATION: DTIC
--38 - DECLASSIFICATION DATE: OADR
--40 - GEOPOLITICAL CODE: 1100
--41 - TYPE CODE: N
--43 - IAC DOCUMENT TYPE:

UNCLASSIFIED

APPROVED FOR PUBLIC
RELEASE - DISTRIBUTION
UNLIMITED